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| FEATURE |

ACCELERATING BLUE TECHNOLOGY VIA SUBSEA ELECTRIFICATION WITH LITHIUM-ION BATTERY INNOVATION

By Leon D. Adams, VP, Southwest Electronic Energy

Monitoring the health of the oceans, producing hydrocarbons from a subsea well, and ensuring subsea defense all require safe sustainable power. Traditional hydraulic-powered systems are fraught with environmental and reliability challenges, but advanced subsea battery solutions safely enable such activities.

Data collected about ocean thermal streams, pollutants and other aspects of the ocean can be wirelessly communicated, therefore, using a reliable advanced subsea battery solution can untether the data acquisition and monitoring equipment.

Smarter and more reliable hydrocarbon drilling and production requires battery power for subsea control systems, subsea intervention, autonomous underwater vehicles, and powerful electric motors. Offshore operations have long relied on environmentally-challenged hydraulic fluid based systems, but need to evolve to smart, clean, efficient electric control and actuated systems, enabled by advanced subsea battery solutions.

Subsea defense and security is increasingly critical in our stealth and cyber-oriented world with competing global powers. Leveraging Blue Technology enables NATO Navies to improve anti-submarine warfare and more safely execute mine countermeasures, which demand more autonomous surface and subsea vehicles with longer mission endurance. Advanced subsea battery solutions provide capability for naval subsea intelligence, surveillance, reconnaissance, undersea warfare, and deception.

The common thread among these innovative subsea applications is safe, reliable, long lasting, and easy to use subsea battery solutions.

Subsea Electric Power

A pressure tolerant lithium-ion polymer battery is ideal for subsea use, compared to traditional lead acid batteries. In 2013, Southwest Electronic Energy (SWE) launched its first commercial pressure tolerant lithium-ion polymer subsea battery pack, SWE SeaSafe, a major breakthrough in subsea power operations. SWE collaborated with Woods Hole Oceanographic Institution on the design, which is radically lighter and smaller than traditional lead acid batteries.

These batteries are easier to install than lead acid batteries, while they don't require a pressure vessel, they can require a pressure balanced oil-filled container, since contacts are not sea-ready. SWE SeaSafe batteries provide cycle lives that are eight times longer than their lead acid counterparts. The SWE SeaSafe line of batteries also performs six times better at low temperatures than standard lead acid batteries.

In 2017, SWE introduced the SeaSafe II® and SeaSafe Direct®, which incorporated lessons learned, reliability improvements and American Bureau of Shipping (ABS) certification. The SWE SeaSafe Direct can be placed directly into the water without a pressure vessel. Its ease-of-use convenience is becoming a growing trend in the industry.

SeaSafe II and SeaSafe Direct batteries have been used in short-duration, high-power demand applications and long-duration low-power demand situations. Applications include autonomous underwater vehicles for propulsion, control, and instrumentation; in remotely located infrastructure equipment for valve control and pipe shearing; and in oceanography sensing set-ups such as those for monitoring the salinity and temperature of ocean water over a period of time.

The SWE SeaSafe batteries are rated to 6,000 meters water depth and deliver 30V and 28Ah, with other sizes available. A series of battery modules can be linked together to meet specific increased voltage needs and in parallel to meet specific increased power and capacity needs with the capability of taking thousands of charges.

Advanced Safety

These smart batteries can track and report the status of the batteries for condition-based monitoring, which is crucial for reliable and safe operations. The integrated Battery Management System (BMS) automatically manages and tracks the safety, reliability, charge and discharge of the batteries and reports technical information on demand.

A built-in user-friendly BMS, patented by SWE, embeds advanced safety and reliability features into each smart module battery.

Safety features are configurable to the application. The BMS is designed to detect and prevent over-and-under voltage conditions and excessive charge and discharge scenarios. It can monitor the charge and discharge temperature while detecting and preventing short circuits and features redundant short circuit fuse protection.

The BMS makes it possible to autonomously control the charge level within each battery module. It gauges load voltage, rate of current and remaining battery capacity. A patented algorithm assesses the state of health and preventive maintenance forecast for the pack. The SeaSafe Observer GUI displays battery state of health and charge status.

Put Them To The Test!

The SWE SeaSafe II and SeaSafe Direct batteries have passed a host of tests to ensure they are safe for subsea use. SWE conducted exhaustive functional and pressure testing at Southwest Research Institute on the batteries for years.

ABS issued a design approval on the batteries in 2017, which included review and approval of more than fifty SWE engineering design, test and product documents. In one particular test, the SeaSafe II and SeaSafe Direct battery module cases were immersed in fire to verify that the case was inflammable.

SWE SeaSafe II and SeaSafe Direct passed the International Standard IEC 62619:2017 Safety Requirements test for non-propagation of forced thermal runaway. For the intentional overcharged cell-induced thermal runaway test, SeaSafe Direct module was manufactured to allow direct overcharging of Cell 4 in order to bypass the built-in BMS safety system. All cells were fully charged before testing. Three SeaSafe Direct modules were placed side-by-side with a modified module in the middle, in oil, inside a stainless-steel enclosure.

Cell 4 in the modified module was overcharged 150% normal charge voltage directly at 6 V at near 150 Amps, bypassing BMS cutoff control. After 30 minutes into the intentional overcharge, the cell went into thermal runaway. The potting split as designed, allowing the cell to vent into the oil as designed. There was no flame and the two adjacent battery modules in the case did not show any damage. There was no thermal runaway propagation from module-to-module.

Other tests SeaSafe II and SeaSafe Direct passed include UL 1642:2012, IEC 62619:2017, IEC 61000-4-2:2008, IEC 61000-4-3:2010, IEC 61000-4-6:2013, IEC 61000-4-4:2012, CISPR 16-2:2016 and UN 38.3:6th Edition.

SWE SeaSafe II and SeaSafe Direct have also been certified to UN38.3 on transport safety. Tests included altitude simulation, thermal, vibration, shock, external short circuit, and overcharge. The tests found that the battery modules comply with UN38.3.

The design and creation of SWE SeaSafe II and SeaSafe Direct brings Blue Technology in to the 21st century.

About the Author

Leon Adams is the vice president of sales in lithium and lithium-ion battery solutions, product definition and technical customer support at Southwest Electronic Energy Corp. He is a member of the Marine Technology Society, Society for Underwater Technology and Institute of Electrical and Electronics Engineers. Adams holds an M.B.A. and B.S. in Engineering Physics.

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- 6X Longer Battery Life Time
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